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Developments and Uses of the Newer Agricultural Fungicides and Bactericides

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Choice of Materials

The recent developments in agricultural fungicides have had two aims – increasing toxicity to the fungus and decreasing injury to the host plant. For the corresponding insecticides, the problem of crop injury has commonly been of much less importance, as the materials that kill insects by disrupting their vital processes are unlikely to affect the entirely different vital processes of plants.

Between green plants and fungi, on the other hand, the similarities in metabolism outweigh the differences. Differences do exist, such as the production of starch and cellulose by plants and not by fungi. Plants also usually have a highly developed protecting cuticle or bark. Thus there is a certain margin for selective toxicity between plant and fungus, but it is a narrow one, and it has always imposed limitations on the use of fungicides, because of the requirement to avoid spray damage and other forms of phytotoxicity. Consequently the development of new fungicides, while it has included the derivation of more fungitoxic materials, continues to be influenced by the need to find substances that can be applied with the minimum of injury to plants, particularly to specific varieties liable to damage by the older therapeutants – the inorganic compounds of copper or sulphur.

Further restrictions are imposed by the necessity to avoid hazards to operators and to obviate disfiguring spray deposits and deleterious effects of residues on processed products. Although the last two requirements apply only to parts of plants grown for human consumption, they are likely to be of increasing importance in the future choice of fungicides.

The materials recently developed for use against plant diseases fall into two groups: synthetic organic compounds and culture-derived anti-biotics. Chemically, the majority of the synthetic organic fungicides may be roughly divided into the six groups listed below, with representative examples:

(1) thiocarbamates and thiuram sulphides, e.g., thiram, ferbam, nabam, zineb;
(2) organo-mercurials, e.g., Agrosan, Ceresan, Panogen, phenyl mercury chloride;
(3) chlorinated hydrocarbons, e.g., chloropicrin, ethylene dibromide, chlorobromopropene, pentachlorphenol, chlornitrobenzenes;
(4) quinones, e.g., dichlone, tecnazene, chloranil;
(5) azoles, e.g., pyrazoles, glyodin;
(6) phthalimides, e.g., captan.

Within both the synthetic organic fungicides and the anti-biotics there are certain materials which have been reported as systemic fungicides.

In the present article, these compounds and the antibiotics will be treated on a basis of field use, the broad classification being into materials employed on: (*a*) seeds and soil; (*b*) stems and branches; (*c*) leaves and fruit.

Seed and Soil Treatments

Thiram (tetramethylthiuram disulphide) is now used as a seed dressing for flax and for vegetable crops (peas, beans, carrots, beets, spinach) at rates of 1–4 ounces per bushel. Chloranil (tetrachloro-*p*-benzoquinone) is applied at 2 ounces per bushel to seeds of peas, beans, lettuce and seed corn to reduce infection by parasitic soil fungi. In the seed dressing of cereals, organomercury compounds are predominantly used, examples of the more recently developed products being: Agrosan GN (tolylmercury acetate), Ceresan M (*N*-(ethylmercuri)-*p*-toluenesulphonanilide), Leytosan (phenylmercuriurea), Panogen [cyano (methylmercuri) guanidine]. These compounds, in contact with moist soil, give rise to volatile mercury derivatives which affect not only the fungi on the seed coat, e.g., bunt (*Tilletia caries*), but also pathogens such as *Helminthosporium* spp., which are present in the outer tissues of the seed.

Preliminary tests suggest that seeds steeped in dilute solutions of antibiotics, such as streptomycin and actidione, take up sufficient of the material to inhibit the growth of mycelium within the testa. Actidione, however, is phytotoxic to pea seeds at 5 parts per million.

A development in the protection of seedlings from root and stem rots is the application of fungicides not to the seeds but to the soil of the seed-bed. Thiram, incorporated with the upper 1 ¼ inches of soil in immediate proximity to seeds of sugar beet, at the rate of 3-4 pounds per acre, has markedly reduced root rot in the seedlings. No injury results up to 70°F., but above 80° root and hypocotyl damage occurs and some seedlings may be killed.

A more drastic means of soil treatment is by the use of fungicidal fumigants which have to be allowed to evaporate before the treated ground can be sown. In irrigated areas of western U. S. A., chloropicrin (trichloro-nitromethane), methyl bromide, dichloropropene, and chlorobromopropene have been used in the field as soil fumigants, and there is some evidence that part of their effect is due to the selective encouragement of micro-organisms antagonistic to pathogenic fungi. Most of these fumigants are hazardous to the operator and their application would require the services of specialists.

Treatment of Stem and Branch Diseases

The fungi and bacteria attacking stems and branches may invade through obvious wounds or through leaf scars; another path of attack is from the roots up into the stem. In the treatment of all these types of attack, the use of systemic fungicides is becoming of increasing importance. These fungicides are therefore conveniently considered here as treatments for stem and branch diseases, although the initial application of the fungicide may in some instances be made to soil or foliage.

Used broadly, the term "systemic fungicidal action" may indicate: (1) the antidoting of toxins or enzymes produced by the fungus in the vascular system; (2) modification of the metabolism of the host plant, making it a less favorable environment for the pathogen; (3) direct fungitoxic action of a material taken in by the plant and translocated through the tissues.

The antidoting of toxins is exemplified by the use of 8-hydroxy-quinoline benzoate to alleviate the symptoms of Dutch elm disease. This material is now recommended for use on elms in New England as a systemic preventive and is claimed to give 50 percent control when thus applied.

Reduction of plant susceptibility by the use of materials having slight growth-regulating effects is instanced by the recommendation to use 4-chloro-3 : 5-dimethyl phenoxy ethanol for watering glasshouse carnations subject to *Fusarium* wilt. Results obtained with this material have however been inconsistent.

The best authenticated example of the true systemic fungicidal effect is in the use of the antibiotic griseofulvin, which has been re-isolated after passing through the plant. In glasshouse trials, systemically-

applied griseofulvin at 0.05 percent has given control of *Alternaria solani* attack on tomato and *Botrytis fabae* of bean, without causing plant damage.

On the field scale, the chief employment of systemics against plant diseases has been in the use of the systemic bactericide streptomycin.[1] In New Zealand, streptomycin at 500 p.p.m., sprayed on to stems of young peach trees, has prevented wound infection by *Pseudomonas syringae*, the cause of stone-fruit blast. In North America, fire blight (*Bacterium amylovorus*) of apples and pears has been satisfactorily checked by three applications (at early blossom, full blossom and petal fall) of 100 p.p.m. streptomycin.

Apart from the use of systemics, there have been developments in the use of fungicides on woody stems to prevent spore formation on existing lesions. Thus, phenyl mercury chloride at 0.3 percent if applied in winter to apple tree cankers caused by *Nectria galligena* markedly reduces spore infection on these cankers for approximately twelve months. Such a rate of application is uneconomic, but a similar effect against *Elsinoe veneta*, the cause of raspberry cane spot, has been obtained using phenyl mercury chloride at 0.005 percent.

Foliage and Fruit Sprays

The major use of agricultural fungicides is on leaves and fruits. Here the inorganic compounds of copper and sulphur have been extensively employed for many decades, but in many instances their phytotoxic action has detracted from their value in controlling disease.

The first synthetic organic fungicide to be widely adopted as a crop protectant was salicylanilide ($OH.C_6H_4.CO.NH.C_6H_5$). A suspension of 0.025 percent is used in glasshouses, mainly against tomato leaf mold (*Cladosporium fulvum*). No deleterious effect of the spray residue on the fresh or processed tomatoes has been recorded.

Organo-mercury fungicides have come into use as foliage sprays, particularly for apples. In Britain, phenyl mercury chloride, phenyl mercury nitrate and the diphenyl mercuric salt of di-2 : 2-naphthylmethane-3 : 3-disulphonic acid are used: in North America, phenyl mercuric acetate and phenyl mercury triethanol ammonium lactate are commonly employed. These mercurials have a relatively short protectant action but are valuable as post-infection sprays against apple scab. Certain apple varieties (e.g. Cox's Orange Pippin) may show damage following mercury sprays in wet seasons and, in U. S. A., mercurials may sometimes reduce fruit set and delay ripening.

The thiocarbamates have been extensively used on potatoes and fruit crops. Zineb and maneb at 0.1 percent control potato blight satisfactorily if applied weekly. Thiram at 0.25 percent has given successful control of *Botrytis cinerea* on strawberries, but the spray residue induces taint in the canned fruit. Ziram is used for apple scab control in preference to the dark-colored ferbam which leaves a disfiguring residue.

Dichlone (2 : 3-dichloro-1 : 4-naphthaquinone) is a highly fungitoxic material, but its use on foliage and fruit is limited by its liability to induce skin irritation and by its phytotoxicity. This may quickly become obvious because of the appearance of necrotic spots on leaves or fruit, or it may show as a delayed action in deferring maturity and reducing blossom bud formation.

Glyodin (2-heptadecyl-2-imidazoline acetate) has the advantage of containing neither metallic radicles, sulphur nor chlorine groups. It is used at 0.375 percent for the control of apple scab and has also been applied to black currants to provide a fungicidal deposit non-objectionable in canning.

Captan (*N*-trichloromethylthiotetrahydrophthalimide) shows promise as a foliage and fruit protectant fungicide with a long period of tenacity. It is generally non-phytocidal and has given satisfactory field performance at 0.1 percent against apple and pear scab, strawberry *Botrytis*, black currant rust and potato blight.

A disadvantage of the organic fungicides – mercurials, thiocarbamates, glyodin and captan – is that they have little or no effect on the powdery mildew fungi, which are controlled by lime sulphur and other inorganic sulphur preparations. Karathane (2 : 4-dinitro-6-caprylphenyl crotonate), at 0.1 percent has given promising results when used

[1] See also Gottlieb, D. 1954. Antibiotics and plant protection. *FAO Plant Prot. Bull.* 3 : 1-3.

against powdery mildew (*Sphaerotheca morsuvae*) on gooseberry varieties damaged by sulphur: its value on apples is still being explored. It has the disadvantage of being a potential skin irritant and its residual effect on processed fruit is unknown.

The antibiotic actidione (cycloheximide) has been tried against powdery mildews of bean, rose and apple, but in general the concentrations of actidione required to ensure fungicidal action have been near the phytotoxic level.

Representatives of spore-suppressant fungicides now being used on foliage are the pentachlor- and tetrachlor-nitrobenzenes. Tecnazene (2 : 3 : 5 : 6-tetrachlornitrobenzene), applied as a 5 percent dust to transplanted lettuces, considerably reduces field attacks by *Botrytis cinerea*. The effect is largely due to the suppression of sporulation of the fungus on existing lesions. These chlornitrobenzenes may cause a temporary check to the growth of the lettuce plant.

Comparisons with the Older Fungicides

In making a broad comparison between the newer fungicides and the traditional materials it is clear that Bordeaux mixture and lime sulphur still show many merits. Indeed, it was a remarkable chance that gave us a century ago two materials exhibiting so many of the qualities desirable in a protectant fungicide. Both Bordeaux mixture and lime sulphur are cheap, effective against a wide range of pathogens, highly tenacious on foliage, and unlikely to injure human beings. Their disadvantages are that they corrode containers and pumps and are bulky. Bordeaux mixture is somewhat troublesome to prepare and lime sulphur unpleasant to use. Both materials show phytotoxic effects on certain species and varieties of crop plants.

The organic fungicides on the other hand are, in general, non-bulky, easy to prepare, pleasant to use, less corrosive and less phytotoxic. Their range of usefulness is narrower than that of lime sulphur and Bordeaux mixture, they require more frequent application and their cost is often higher. It can be expected that the organic fungicides will play an increasing part in the spray program wherever standards of plant disease control are becoming higher. However, in districts where the spraying of plants is at an early stage of development it is usually more satisfactory to advise the use of the older fungicides as a general recommendation, leaving the newer fungicides to be brought in later when needed to meet special requirements.

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A New Design of Sprayer for Reducing Insecticide Hazards in Treating Rice Crop

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In a recent article Fernando *et al* [2] reviewed the various types of spraying and dusting equipment available for applying insecticides against the pests of the rice crop. Mention was made of attempts to design a type of sprayer which would expose the spray operator to the minimum quantity of the insecticide being administered. Factors such as the high temperatures and humidities obtaining in Ceylon which deter the wearing of effective protective clothing by cultivators, the scanty clothing normally worn by rice cultivators in the field, and the high mammalian toxicity of a number of the insecticides in use for the rice plant, emphasize that the design of sprayers is of primary importance in the solution of the problem of protecting rice cultivators against the hazards of insecticides. Furthermore, the incompleteness of the knowledge of the toxicology of insecticides, particularly their chronic human toxicity, demands that every effort should be made to reduce or eliminate the contamination of the human body by these chemicals. It is considered that the sprayer described in the present paper will to a large measure meet these requirements.

Description of the Sprayer

The sprayer that has been developed consists of already existing elements rearranged to fit into a new design. This design [3] is based on a knapsack sprayer of the orthodox type, but the fitting of two spray outlets on the body of the sprayer is advantageous as will be noted later. A "Senior" (Birchmeier & Co. A.G.) knapsack sprayer was used as the test machine.

Two rods *A* and *B*, the greater length of which is disposed vertically, are fixed to the back of the sprayer as indicated in Figure 1. The distance between the vertical portion of these rods can be varied as required. Clamp *C* can be moved up or down the vertical rods, while arm *D*, to which is welded clamp *E*, in each case encircles a spray lance, one end of which is connected to a spray hose leading from one of the spray outlets on the sprayer. The other end of the spray lance carries a "Boom Jet" nozzle (Spraying Systems Co., U. S. A.) which consists of two fan jets so arranged and adjustable as to give a very wide-angled fan of spray.

Possible Adjustments

Screw *a* permits the raising or lowering of the spray lances and also the adjustment of the angle between the two spray lances. Screw *b* permits the adjustment of the angle of the spray lances with the vertical rods. Screw *c* permits adjustment of the length of the spray lance protruding behind the vertical rods. Finally screws *d* and *e* permit the adjustment of the angle between the two rods *A* and *B*.

Purpose of Adjustments

The adjustment of the angle between the two rods *A* and *B*, while possible in the prototype machine, is not essential when the angle between the two spray lances is fixed. The purpose of clamp *C* with screw *a*, as mentioned earlier, is to permit altering the height of the spray lances from the rice crop, an adjustment which is essential, and which would obviously vary according

[1] The writer expresses his sincere thanks to Mr. K. C. Karunaratne of the Division of Agricultural Engineering, Ceylon Department of Agriculture, for his co-operation in the construction of the sprayer described in this paper.

[2] Fernando, H. E., G. V. Weerawardena and P. Manickavasagar. 1954. Paddy Pest Control in Ceylon. Trop. Agriculturist 110 : 159-174.

[3] Patents on the design are pending.

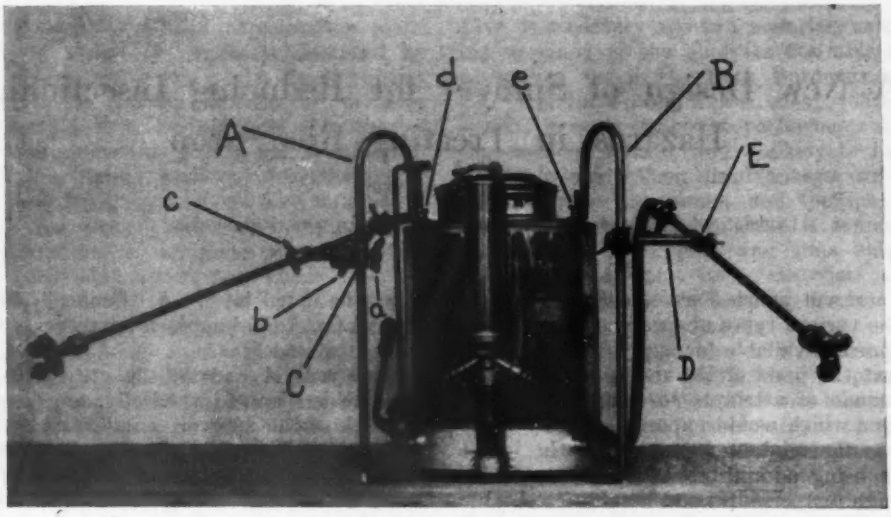

Figure 1. Design of the double-lanced knapsack sprayer. See text for explanation.

to the height of the spray operator and the stage of growth of the crop being sprayed. Clamp *C* also permits varying the angle between the spray lances. As this angle is to be adjusted in accordance with the angle of the fan of spray emerging from each nozzle (and this can be fixed), adjustment of this feature is not essential. Therefore, once the angle between the two lances is determined, it can be permanently fixed by adjusting the clamp by way of a screw on a longitudinal groove on each vertical rod, or by having the vertical rods square in cross-section. The adjustment made possible by screw *b* is essential as it determines the angle at which the spray is directed to the plants. This will necessarily vary according to the height of the spray operator, and the height of the rice crop being treated. This adjustment may however be eliminated with little loss of efficiency, if an optimum angle made by the spray lance with the vertical plane is fixed. The adjustment of the length of the spray lance protruding behind the vertical rods is necessary only when a rice crop at the very early seedling stage is being treated. Even this adjustment can be eliminated if an optimum length of spray lance is attached.

It is therefore apparent that the essential feature which would require variation and adjustment under various operational conditions is the height of the spray lances or nozzles from the crop being sprayed, and this can be achieved by moving the lances along the vertical rods. It should be pointed out, however, that this will be true only if the other features mentioned earlier are optimally fixed.

Performance of the Sprayer

Under practical conditions this sprayer has been found to be easy in manipulation after the operator has received some training in its use. It is not unwieldy and does not over-balance, as the increase in weight of about 8 pounds (this can be reduced by using aluminium alloy fittings) behind the operator, due to the introduction of the two vertical rods and spray lances etc., is not felt by the operator. In six-hour operational spells, up to three acres of half-grown rice crop have been treated with this sprayer. The quantity of spray liquid required per acre to give complete heavy coverage of the crop has been 20 to 25 gallons. A three gallon spray tank was emptied every 15 min-

Figure 2. The double-lanced knapsack sprayer in operation. A. Spraying young rice crop. B. Spraying mature rice crop.

utes by an operator working at a slow walking speed, and the spray mist hit the crop in a very slight arc. The swath width of the spray mist produced by this sprayer under operational conditions was about 16 feet (Figure 2), but spraying was usually carried out in 10-foot parallel strips.

Discussion

During the treatment of the rice crop with insecticidal sprays the exposure of the operators to the hazards of the chemicals may normally arise from one or both of the following sources:

(*a*) inhalation of spray mist or chemical vapors;
(*b*) contamination of the unbroken or the cut skin with the spray fluid.

During spray operations on the rice crop using the orthodox knapsack-type sprayer, the spray is generally directed in front of the spray operator, and as the operator walks straight forward he enters the area of the spray mist, thus inhaling the spray mist. This is even more marked when spraying taller rice plants. With the mist blower or the double- knapsack boom sprayer, a lesser, though considerable, amount of spray mist is inhaled, and in the former this is a feature to be reckoned with, for insecticidal concentrates are involved. When using the sprayer described, however, the spray mist is directed backward and some distance (nearly 4 feet) behind the spray operator, so that under still conditions there is no chance of the spray operator breathing the spray mist. When the wind direction is variable, however, the operator will be exposed to some spray mist, but as the spray operator does not walk into the sprayed areas during operations, the breathing of toxic insecticidal vapors is minimized.

With the knapsack sprayer or the double-knapsack boom sprayer, the spray operator not only walks in the general direction of the spray mist, but he must also walk through sprayed areas. In the case of very small rice plants which usually grow in a few inches of water, the hazard of contamination of the skin or limbs etc. by contact with sprayed plants is at a minimum, though a considerable amount of spray fluid reaches the limbs and hands directly from the spray nozzles. In the case of older rice plants, spraying with these two types of sprayers results in heavy exposure of limbs and hands to the spray fluid adhering to the plant, and to the spray mist as the operator walks through the sprayed area. Furthermore, as the leaves of older rice plants are responsible for numerous cuts on the knees and elbows of operators walking through the crop, the hazard of the penetration of toxic chemicals through the broken skin is further increased. When using the sprayer described in the present paper, hazards of skin contamination in this manner are entirely eliminated, as the operator never walks through a sprayed area.

While no claim is made for the perfection of the sprayer described, the design has been critically examined. If the adjustments regarded as useless when certain features are optimally fixed, are eliminated, then the sprayer will be greatly simplified. In the knapsack sprayer used as a test machine, the pressurizing lever was disposed basally on the sprayer. Better performance will result if the lever is operated in front of and higher than the spray operator's shoulder.

The sprayer described will be of use not only for the treatment of the rice crop with toxic chemicals. It is expected to be of value for the treatment of low crops like onions, cabbage etc., and even tea bushes, against pests or diseases.

Plant Disease Situation in the United States [1]

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Xyloporosis–Cachexia Relations and Transmission Studies in Florida

CACHEXIA was first described [2] on Orlando tangelo (*Citrus paradisi* × *C. reticulata*) in Florida in 1950. Its transmission by buds has been established by experimental evidence. The disease, which has a striking similarity to xyloporosis of sweet lime (*C. aurantifolia*), has been found to be very widely distributed in Florida, affecting a very high proportion of the commercial citrus varieties.

Xyloporosis, which has been known since 1928 in Palestine and since 1938 in Brazil and Argentina, was reported [3] on sweet lime rootstock in Florida in 1951. Identification of this disease in Florida and in South America was based on the similarity of the symptoms to symptoms described for the Palestine disease and no cross-inoculations were made in either case.

The relation between cachexia of Orlando tangelo in Florida and xyloporosis of sweet lime in Palestine cannot be established with certainty until cross-inoculation studies with the Florida disease and the Palestine disease are made. However, in view of the wide distribution and importance of cachexia in Florida, it has become desirable to examine the information available in this connection. For this purpose, J. F. L. Childs of the Horticultural Crops Research Branch, United States Department of Agriculture, stationed at Orlando, Florida, in a recent report, discusses the relation of cachexia to xyloporosis as known in Florida and presents the results of his transmission studies. In his report which is reviewed here, the term "cachexia" refers to the Orlando tangelo disease and the term "xyloporosis" to the sweet lime disease, but he considers them to be caused by the same virus or strains of the same virus.

Comparison of symptoms between cachexia and xyloporosis. It was observed that certain symptoms of the two diseases are not identical, e.g., phloem discoloration, which is characteristically pronounced in cachexia-affected Orlando tangelo trees, is not present or is at least much less marked in xyloporosis-affected sweet lime. Also, wood pitting was reported as a characteristic of xyloporosis on unbudded seedling sweet lime trees in Palestine, but has not been observed on unbudded Orlando tangelo seedlings.

Differences in the degree of symptom expression such as phloem discoloration may be the result of differences in varietal response. For example, gum impregnation of the phloem tissues is pronounced in Orlando tangelo, weak in Williams tangelo, and apparently absent in Watt and Webber tangelos infected with the causal agent of cachexia. In Texas it was also observed that symptoms are slower to develop (by two years) in Satsuma mandarin (*Citrus reticulata*) than in Orlando tangelo. Nocatee tangelo trees, seen in Israel and said to be affected with xyloporosis, showed phloem discoloration as pronounced as that exhibited by cachexia-affected Orlando tangelo trees in Florida.

Bud transmission of cachexia. In a previous experiment three lots of scions from cachexia-infected parent Orlando tangelo trees expressed symptoms in 95.3, 86.7, and 94.2 percent of the trees four years after budding on Rough lemon (*Citrus limon*) rootstock. In five years symptom expression of all these three lots was 100 percent. In contrast, lots budded with scions from cachexia-free trees were 100 percent free of symptoms.

In recently completed experiments 15 cachexia-infected Orlando tangelo buds, each

[1] This report is based upon material submitted by Collaborators of the Plant Disease Epidemics and Identification Section, Agricultural Research Service, United States Department of Agriculture.

[2] Childs, J. F. L. 1950. The cachexia disease of Orlando tangelo. Plant Dis. Reptr. 34 : 295-298.

[3] DuCharme, E. P. and R. F. Suit. 1951. Xyloporosis of citrus in Florida. Plant Dis. Reptr. 35 : 556-557.

from a different tree, were inserted in Orlando tangelo seedlings. Because of the unfavorable weather conditions, all the buds died shortly after insertion, but four years later 13 of the 15 seedlings expressed bark symptoms of cachexia. In the control lot, in which 15 cachexia-free buds also died after insertion in Orlando seedlings, none of the trees developed cachexia symptoms within the same period under observation.

The results were again confirmed by another experiment, in which single buds from each of five infected Orlando tangelo trees were inserted in five Orlando tangelo seedlings and subsequently all died. Within a four year period, the five budded seedlings developed bark symptoms of cachexia, whereas five unbudded seedlings of the same lot showed no symptoms. Thus it seems safe to assume that Orlando tangelo seedlings will develop cachexia symptoms within two to five years, if cachexia virus is present.

Bud transmission of Florida xyloporosis. Buds from two Hamlin orange (*Citrus sinensis*) trees and five Temple orange (*C. sinensis* × *C. reticulata*) trees on Florida sweet lime rootstock affected with xyloporosis were propagated on seven Orlando tangelo seedlings. Subsequently six of the buds died, but the rootstock with the living bud, as well as three of the stocks with dead buds, developed bark symptoms typical of cachexia. Conversely, five buds of cachexia-infected Orlando tangelo were propagated on seedlings of Palestine sweet lime. One of these buds died, but all sweet lime stocks developed typical xyloporosis bark symptoms within a four year period.

Transmission of cachexia through seed. Fifty tangelo trees grown from seed of cachexia-infected Orlando parent trees and 50 trees from seed of cachexia-free trees developed no symptoms within a four year period. Of 135 Orlando tangelo seedlings from a commercial source, some unbudded and others budded with cachexia-free buds, none developed cachexia symptoms within a period of four to six years. However, in another lot of 121 unbudded Orlando tangelo seedlings from the same commercial source, three seedlings developed mild symptoms suggestive of cachexia infection at the age of six years. Whether the causal agent of cachexia was transmitted through the seed or by insects or whether root graft transmission occurred is unknown.

As part of another experiment, 30 one year-old Rough lemon seedlings were obtained from a commercial nursery and set out at the Orlando station non-budded. Ten of these trees died, but at the end of four years eight of the remaining 20 trees showed brown gum-impregnated spots in the phloem of the lower trunk suggestive of cachexia.

Transmission of xyloporosis through seed. In an experiment using Florida sweet lime seedlings approximately one year old, 10 seedlings were budded with cachexia-free Orlando tangelo buds, 10 were inoculated with an actinomycete isolated from citrus roots as part of another experiment not related to cachexia, and 10 were treated as checks on the actinomycete inoculation. Two months later the seedlings were set out in an experimental planting at the Orlando station. Within four years mild symptoms of xyloporosis, wood pitting and slight discoloration of the phloem, developed in the region of the trunk above the root crown in the following numbers of the sweet lime trees: five of the trees budded with cachexia-free Orlando tangelo buds, seven of the trees inoculated with the actinomycete culture, and eight of the check trees that were cut in a sterile manner but not inoculated. Thus, of 30 sweet lime seedlings, 20 developed bark symptoms of xyloporosis.

Conclusions. Cachexia symptoms have been consistently produced on Orlando tangelo seedlings through inoculation with buds from infected trees. Buds from trees on xyloporosis-affected sweet lime rootstocks in Florida gave rise to typical cachexia symptoms when propagated on Orlando tangelo seedlings. Reversely, typical xyloporosis symptoms were induced in Palestine sweet lime rootstocks when they were budded with buds from cachexia-affected Orlando tangelo trees. From these results it appears that the difference between Orlando tangelo and sweet lime in symptom expression may be a matter of differences in host response.

Transmission of the causal agent of cachexia, probably a virus, through the seed of Orlando tangelo is apparently rare, if it occurs at all. On the other hand, the causal agent of xyloporosis (probably the same virus) was apparently transmitted through

66 percent of 30 sweet lime seeds. The xyloporosis symptoms reported from Israel on unbudded sweet lime seedlings could be explained on the basis of the present evidence that xyloporosis is transmissible through the seed. Transmission of cachexia through the seed of Rough lemon is believed to be indicated but not fully established. Since the possibility of seed transmission of xyloporosis is of great importance to the citrus budwood certification programs, experiments are under way to verify those preliminary results.

It should be emphasized that xyloporosis or cachexia cannot be controlled solely through propagating buds free of the virus, if seedlings used as rootstocks carry the causal agent of the disease. Also the assumption that citrus nucellar seedlings are *a priori* disease-free may be questioned in the light of the experimental results.

Outbreaks and New Records

Belgium

Ministry of Agriculture, Brussels

Outbreaks of Mediterranean Fruit Fly

THREE outbreaks of the Mediterranean fruit fly (*Ceratitis capitata*) were discovered in 1955 in the neighborhood of Brussels. In two cases, only peach trees were attacked; in the third, the pest attacked peach trees with ripening fruit in August-September, and pear trees of the varieties Durondeau and Bonne Louise d'Avranches.

The Mediterranean fruit fly was first recorded in Belgium toward the end of 1952, on peach trees in a small garden at Mont-Saint-Amand. The pest was unable to overwinter then.

(The above information was received through the European and Mediterranean Plant Protection Organisation.)

Ethiopia

JEAN B. H. LEJEUNE

Expanded Technical Assistance Program, FAO

Occurrence of Black Coffee Stem Borer

A Bostrychid stem borer, *Apate indistincta* Murray, was found to attack coffee trees at Ambo, Province of Shoa. It was first observed in May 1955 and later surveys reveal that it occurs rather commonly in the coffee plantings of that area. The adults damage the trees by boring upward into trunks and branches and producing tunnels. The infested trees are weakened by the tunnels and become liable to break under wind pressure. The larvae seem to develop in the wood as it decomposes.

Apate indistincta is known to be a coffee pest in East Africa where it has been recorded from Nyasaland, Kenya, Tanganyika and Uganda. Infestation has also been reported in tung-oil tree (*Aleurites* sp.), almonds and bamboo.

The identification was made by the Commonwealth Institute of Entomology.

Plant Quarantine Announcements

France (Overseas Territories)

Ministerial Decree of 5 January 1956 relating to the importation of cuttings, seedlings and seed of sugar cane, published in the *Journal officiel de la République française*, Vol. 88, No. 10, 13 January 1956, repeals the Decree of 30 September 1952 on the same subject (see *FAO Plant Prot. Bull.* 1 : 45. 1953).

The new Decree requires for the importation of cuttings, seedlings and seed of sugar cane from any country into the overseas departments of Guadeloupe, Guyana and Martinique, a phytosanitary certificate attesting that the materials originated in fields under control situated in an area free from any virus disease, leaf scald caused by *Xanthomonas albilineans*, and *Tomaspis saccharina*.

French Oceania

Decree No. 55-1219 of 13 September 1955, published in the *Journal officiel des Etablissements français de l'Océanie* Vol. 104, No. 23, 31 October 1955, establishes conditions for the application of Law No. 52-1256 of 26 November 1952 relating to the organization of plant protection in territories under the jurisdiction of the French Ministry of Overseas (see *FAO Plant Prot. Bull.* 1 : 77. 1953). It contains the following provisions concerning import and export control.

Plants, parts of plants, seeds, soil, manures, composts and containers used for their transportation may not be imported, unless accompanied by a phytosanitary certificate issued by the qualified authority of the country of origin attesting that they are free from all parasites. They will be inspected on arrival. Containers of plant origin are subject to the same restrictions.

Such products and materials intended for exportation will be inspected by the Plant Protection Service which will issue phytosanitary certificates indicating the origin and sanitary conditions.

The Plant Protection Service is authorized to determine the measures and treatments to be taken with regard to the products and materials intended for importation or exportation and found to be contaminated. The Service may also establish conditions under which the products and materials may be imported or exported without phytosanitary certificates.

United Kingdom (England and Wales)

The Importation of New Potatoes and Raw Vegetables Order, 1956, which came into operation on 21 March 1956, modifies for specified periods of 1956 the restrictions imposed by the Importation of Plants Order, 1955, in respect of new potatoes and certain raw vegetables from certain specified European countries.

New potatoes. New potatoes grown in the countries specified hereunder may be imported in 1956 during the indicated periods:

France	21 March–15 June
Portugal, Spain	21 March–20 May

Consignments of such new potatoes must be accompanied by a prescribed certificate and the following requirements must also be fulfilled:

(*a*) They have been grown at a distance of at least 2 kilometers from any place where the wart disease (*Synchytrium endobioticum*) or ring rot (*Corynebacterium sepedonicum*) has occurred at any time;

(*b*) they have been grown in a district where an intensive system of control of Colorado beetle (*Leptinotarsa decemlineata*) is in operation; and

(*c*) they have been riddled and thoroughly washed and are free from soil and Colorado beetle infestation.

Vegetables. Raw vegetables mentioned below grown in the countries and districts specified may be imported in 1956 during the indicated periods:

From Belgium (Districts of Louvain and Malines), France (Districts of Barfleur, Caen, Creances, Lannion, Nantes, Perros-Guirec, Rennes and Saint Pol de Léon), and the Netherlands (all districts):

Cauliflowers, trimmed: 1 April–15 May; Carrots, with foliage not exceeding 5 inches: 1 April–15 October

From Belgium (Districts of Louvain and Malines) and the Netherlands (all districts):

All other raw vegetables (including lettuce) except root vegetables free from foliage, asparagus, aubergines, capsicums, cucumbers, green beans, green

peas, marrows, mushrooms, onions, shallots, pimentos, pumpkins, tomatoes and witloof chicory: 1 April–30 April

From France (all districts):

Globe artichokes: 1 April–15 October

From the Netherlands (Westland district and the Islands of the Province of South Holland only):

Cauliflowers, trimmed: 1 April–31 May

Consignments of such raw vegetables must be accompanied by a prescribed certificate and the following requirements must also be fulfilled:

(*a*) They have been examined and are believed to be free from Colorado beetle infestation; and

(*b*) they have been grown in a district where an intensive system of control of Colorado beetle is in operation.

Viet-Nam

Four orders dated 30 September 1955 were published in the *Journal officiel du Viet-Nam* Vol. 8, No. 48 on 15 October 1955.

1. Order No. 564-CN modifies Order No. 418-Cab-SG-SE of 22 June 1953 establishing general measures for sanitary inspection of imported plants or plant products (see *FAO Plant Prot. Bull.* 2 : 31-32. 1953). The importation of plants, parts or debris of plants, unmanufactured or unmilled products, soil and packing materials capable of carrying plant diseases and pests are to be subject to the general restrictions established by the 1953 Order and to special measures ordered by the Ministry of Agriculture for certain plants and parts thereof. Plants or plant products for scientific research and not exceeding 50 kilograms may be imported by public services free of duty.

2. Order No. 566-CN revokes Order No. 420-Cab-SG-SE of 22 June 1953 establishing ports open for the importation and exportation of plant and plant products (see *FAO Plant Prot. Bull.* 2 : 32. 1953). The ports designated temporarily by the new Order are as follows:

In central Viet-Nam: Tourane (airport and seaport); Hué (airport).

In south Viet-Nam: Tan-Son-Nhut (airport and seaport); Saigon (airport and seaport); also customs offices of Go-Dau-Ha, Loc-Ninh and Tan-Chau.

All customs posts which will be established along the Cambodia-Viet-Nam and the Laos-Viet-Nam borders.

3. Order No. 563-CN amends Order No. 417 Cab-SG-SE of 22 June 1953 establishing general measures for sanitary inspection of exported plants and plant products.

4. Order No. 565-CN replaces Order No. 419-Cab-SG-SE of 22 June 1953 establishing the means of collecting taxes for phytosanitary operations.

News and Notes

Changes in National Plant Protection Services

Egypt. Mr. I. Bishara recently succeeded Dr. Mahmoud Hosni as Director General of the Crop Protection Department, Ministry of Agriculture. Mr. Bishara was formerly the Director of the Entomological Section. The address of the Department is as follows:

Crop Protection Department
Ministry of Agriculture, Dokki
(Ibrahim Bishara, Director General)
Plant Quarantine Section
Customs Building, Alexandria
(Sadek El Sayed Mowafi, Director)

England and Wales. Mrs. D. P. Brooke recently succeeded Mr. P. G. Inch as Head of the Plant Health Branch. The address is:

Plant Health Branch
Ministry of Agriculture, Fisheries and Food
Whitehall Place, London, S. W. 1
(Mrs. D. P. Brooke, Head)

India. The Directorate of Plant Protection, Quarantine and Storage has moved to a new address. Dr. V. P. Rao, formerly Assistant Director in charge of foreign quarantine, has been transferred to take charge of biological control, and his successor has not yet been appointed. The new address is:

Directorate of Plant Protection, Quarantine and Storage
4/19, Asafali Road
Ajmeri Gate Extension, New Delhi
(Dr. K. B. Lal, Plant Protection Adviser to the Government)

Saudi Arabia. Mr. Mohamed Mahmoud El-Salhy, formerly of the Plant Quarantine Section of the Egyptian Ministry of Agriculture, has been appointed as plant quarantine expert in the Ministry of Agriculture. Mr. El-Salhy is engaged in the organization of a plant quarantine division under the newly established Plant Protection Department.

FAO Working Party on Rice Breeding

The Working Party on Rice Breeding was established by FAO under the framework of the International Rice Commission in 1950. Its sixth meeting was held at Penang, Malaya, 5 to 11 December 1955 and was attended by representatives from fifteen governments and observers from the South Pacific Commission, the U. S. Operations Mission and the Rockefeller Foundation. Several problems relating to rice diseases and pests were discussed, among which the following are of particular interest.

Breeding for blast resistance. From information furnished by six countries, the following standard procedures were recommended:

Artificial infection should be carried out on 20-40 day-old seedlings inside a greenhouse, including at least 25-50 seedlings of each variety or progeny. The seedling test is important in eliminating susceptible varieties or progenies at an early stage. In field tests for adult plant resistance 100 plants should be the minimum unit. A susceptible variety should always be grown close to the varieties to be tested, and if necessary; all varieties sprayed with heavy spore suspensions. The promising varieties should be tested in the field for a minimum of two years, and in as many localities as possible. The specialization of the fungus should first be determined in different localities.

Physiological diseases. In India, a disease similar to the penyakit merah disease of Malaya was most prevalent when the oxygen requirement was high, and was associated with the presence of reduction products in the root zone. Application of phosphate and draining the fields reduced the severity of this disease, but the effect of phosphate was not consistent. In East Pakistan, the pansuk disease was associated with stagnant water and partial recovery could be obtained by drainage and application of fertilizers. In Burma, application of phosphates was found to alleviate the diseases myit-po and amyit-po even when applied after the diseases had appeared, and another physiological disease, yellowing, was cured by the application of sulphur or sulphates.

In the United States, straighthead occurs on sandy soil under continuous flooding. The disorder can be partly cured by draining at the critical period which probably corresponds with the time of panicle differentiation.

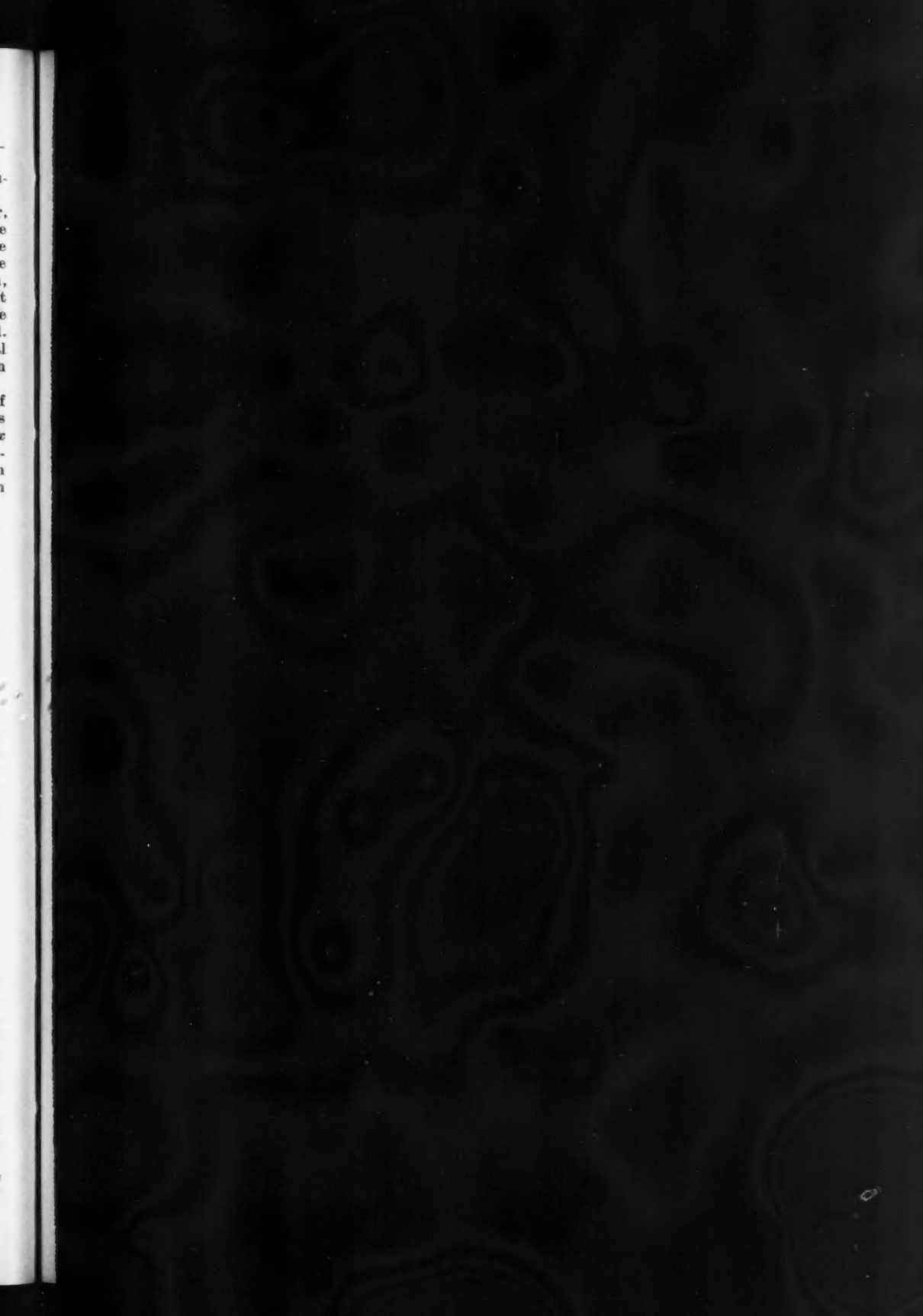
In Ceylon, experimental results indicate that the amount of growth of the rice and the intensity of the physiological symptoms were found to be correlated with the concentration

of the various products of reduction, many of which are probably toxic when present in sufficiently high concentrations. Ferrous and manganous ions were the predominating constituents in the drainage water, being present in concentrations of over 500 p. p. m. and 80 p. p. m. respectively at certain periods.

In the United States, analyses of soils from submerged padi fields in which physiological diseases occurred usually indicate a high iron content and a consistent manganese/iron ratio of less than 1 : 10. This ratio appears to be more important than the total amount of either element.

In Indonesia, it appears that any agricultural practice which makes padi soils more permeable to oxygenated water is beneficial in preventing physiological disease. The good effect of phosphate is ascribed partly to the diminution of ferrous iron in the soil solution, partly to the stimulation of root formation and partly to the stimulation of algal growth.

In the Tanjong Karang district of Selangor, Malaya, soon after rice was planted there were large amounts of iron and organic matter in the soil but grain yields were very high. On the other hand, in old established areas in Kedah, although iron has been leached out, penyakit merah sometimes occurs, suggesting that some factor other than excess of iron may be involved. The important factor probably is not the total amount of iron in the soil but the amount in solution.

In North Borneo, the orange type of leaf symptom occurred in rain-fed areas and was found to be caused most probably by *Nephotettix* attack. Similar symptoms had also been observed in Malaya, but there were many cases in which the disease symptoms appeared when *Nephotettix* was not present.

Roma - Tip. del Senato del dott. Giovanni Bardi